

R005-07

A 会場 : 11/26 PM3 (16:40-18:25)

16:55~17:10:00

2022 年トンガ噴火の水蒸気異常が極中間圏雲活動に与える影響に関するひまわり 8 号/9 号の観測に基づく研究

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Research on the impact of the 2022 HTHH Eruption's water vapor anomaly on PMC activities based on Himawari-8/9 observations

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Polar mesospheric clouds (PMCs), also known as noctilucent clouds (NLCs), are the highest clouds in the terrestrial atmosphere. They consist of water ice particles, which can be formed in the mesopause region (80-85 km) during the polar summer with extremely low temperature conditions. The water ice particle formation is considered to be highly sensitive to temperature and water vapor. For over a century, the potential relationship between large volcanic eruptions, such as the 1883 Krakatoa, and PMC activity has been discussed. However, this relationship remains poorly understood due to a lack of observational data and the rarity of such large-scale events. The Hunga Tonga-Hunga Ha'apai (HTHH) submarine volcanic eruption on January 15, 2022 (20.5°S, 175.4°W) was a large-scale event that injected an unprecedented amount of water vapor, approximately 146 ± 5 Tg (or approximately 10% of the stratospheric H₂O burden), into the stratosphere (at an altitude of 50-55 km). This injected water vapor subsequently spread globally, reaching the polar mesopause regions approximately two years after the eruption. This study examines the impact of the HTHH eruption-originated water vapor anomaly on PMC activities using satellite observations. We analyzed the occurrence rate (OR) of PMCs using data from the Japanese geostationary satellites Himawari-8/AHI and Himawari-9/AHI, as well as temperature and water vapor volume mixing ratio (H₂O VMR) data from the Aura/Microwave Limb Sounder (MLS), from 2015 to 2025.

Monthly averages were calculated for January (Southern Hemisphere, SH) and July (Northern Hemisphere, NH) within the latitude range of 65-81°S/N and altitude range of 77.8-87.9 km. To extract the effects of water vapor anomalies on the PMC variations, at first, we reproduced the temperature-dependent components in the PMC OR variability using a linear regression based on the 2015-2021 relationship. Then, we remove the reproduced components and derive residuals as temperature-independent components in the PMC OR variability. These residuals are defined as Δ PMC. As a result, we found a significant Δ PMC increase ($+15 \pm 5\%$) in January 2024 in the SH. This Δ PMC increase was associated with the significant increase in H₂O VMR ($+0.88 \pm 0.04$ ppmv, or 15.8%) compared to 2015-2021 averages. These associations would strongly suggest that the water ice formation was enhanced by the water vapor anomalies mainly induced by the 2022 HTHH eruption.

These findings would represent the first observational evidence of a relationship between eruption-originated water vapor injection and PMC activity, a topic that has been discussed since the 1883 Krakatoa eruption. This research advances our understanding of the horizontal and vertical coupling processes within the middle and upper atmosphere influenced by large volcanic eruptions.